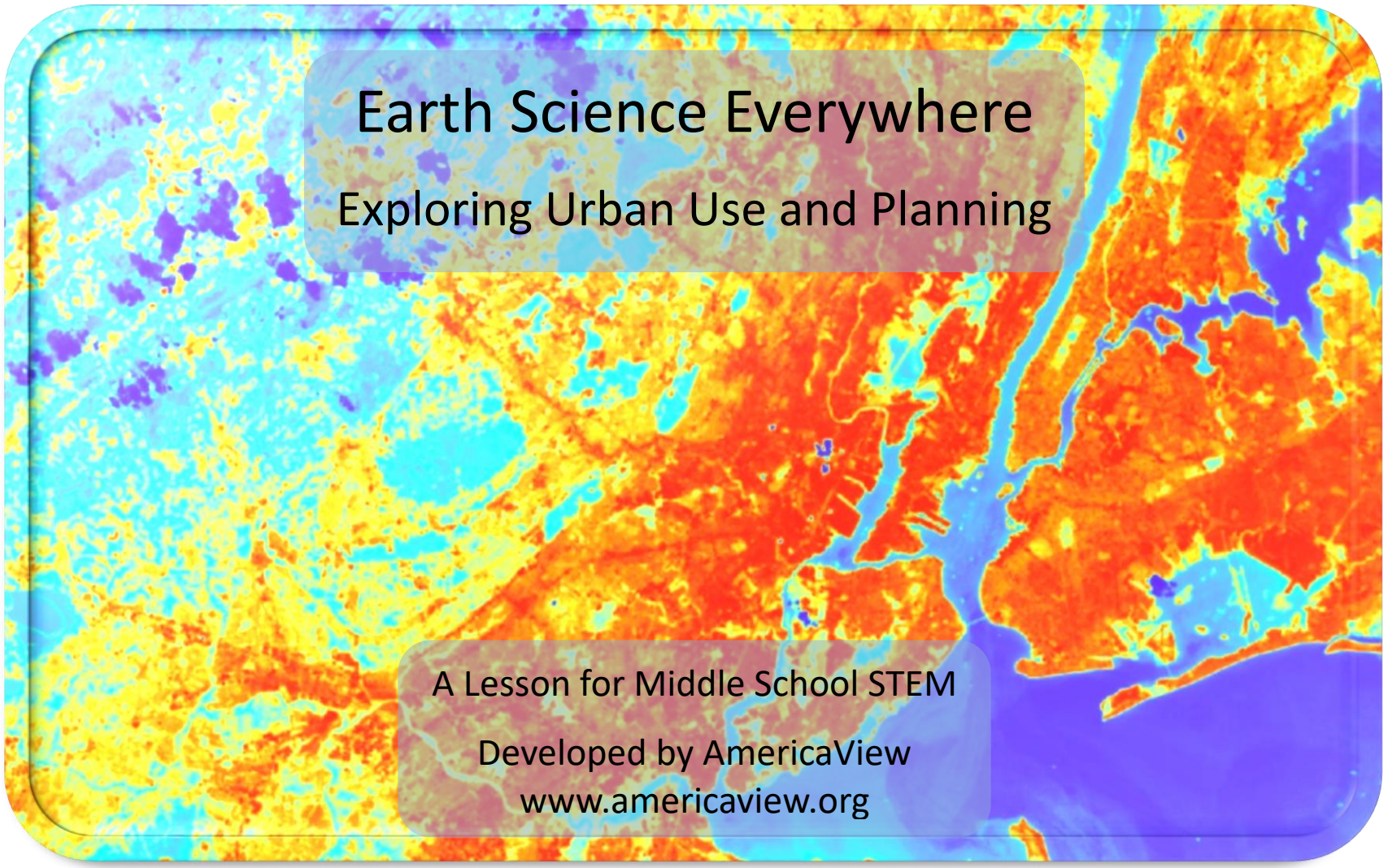
Earth Science Everywhere
Exploring Urban Use and Planning
A Lesson for Middle School STEM
Developed by AmericaView
www.americaview.org

Contents

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Introduction

This lesson seeks to engage students in an examination of urban land use and its growth. Along with looking into urbanization, the impacts of urbanization are described and sustainability efforts to migrate the impacts. The lesson content provides opportunities for students to meet Next Generation Science Standards performance expectation **MS-ESS3** and National Geographic Standards 1 and 14, see next page for details. This lesson is best suited for a STEM enrichment class or as an enrichment activity included as part of a larger science and geography curriculum. It was written with a middle school audience in mind but could be adapted for high school students.

This lesson refers to electromagnetic spectrum and remote sensing topics. It is recommended that the "Exploring the Electromagnetic Spectrum" lesson is completed first.

Keywords**:** Urban, Land use, Urban heat island, Satellite imagery, Sustainability

Time Frame**:** 60 minutes (with additional activities to extend lesson another 15-45 minutes)

Materials: In order to complete the activities in this Lesson, the following materials/resources are essential:

- Internet access
- One computer per pair of students (one-to-one is preferred)
- Google Earth
- Smartboard or other projection system

Background Information

Cities are hubs for ideas, commerce, culture, science, productivity, social, human and economic development. In 2008, for the first time in history, the global urban population outnumbered the rural population. This milestone marked the advent of a new *'urban millennium'* and, by 2050, it is expected that two-thirds of the world population will be living in urban areas. With more than half of humankind living in cities and the number of urban residents growing by nearly 73 million every year, it is estimated that urban areas account for 70 per cent of the world's gross domestic product (GDP) and has therefore generated economic growth and prosperity for many. (Source: United Nations Sustainable Development Goals Knowledge Platform, https://sustainabledevelopment.un.org/topics/sustainablecities)

Although cities bring benefits to people, the growth of cities can result in congestion, sprawl, pollution and inequality. Achieving sustainable urban growth and a thriving urban future for all is a crucial global challenge. Given the importance of this topic to global development efforts, recent movements pushing to address sustainable development from an urban perspective have taken place throughout the world. Results from this movement can be seen in the inclusion of a stand-alone goal on cities and urban development in the 2030 Agenda, **Sustainable Development Goal 11**, "*make cities and human settlements inclusive, safe, resilient and sustainable*" (Source: United Nations Department of Economic and Social Affairs Sustainable Development, https://sdgs.un.org/goals/goal11).

Satellite imagery helps scientists to monitor the changes in our landscapes and to study the effects of urbanization. Landscapes that were largely rural and agricultural 50 years ago have been filled with residential and commercial development. Capturing satellite image pairs many years apart using the Landsat satellite missions shows the contrast between vegetation, water, fallow fields that have been converted to buildings, roads, and paved surfaces.

When urban and suburban areas grow, some of the impacts on surrounding natural and agricultural ecosystems are obvious: “green space” simply disappears, along with the wildlife that lived there. The vegetation that remains—in parks, along roads, or at the fringes of cities and town—is changed by the development as well. Spring comes sooner because urbanized areas are often warmer than the surrounding landscape. Pavement, vehicles, and heat created by energy use can raise the temperature up to 10 degrees Fahrenheit compared to surrounding rural areas. This increased surface temperature is known as the **Urban Heat Island**. (Source: NASA Earth Observatory, Urbanization Between Washington, D.C. and Baltimore, https://earthobservatory.nasa.gov/images/8049/urbanization-between-washington-dc-and-baltimore?src=ve)

An urban heat island is a phenomenon that is best described when a city experiences much warmer temperatures than in nearby rural areas. The sun’s heat and light reach the city and the country in the same way. The difference in temperature between urban and less-developed rural areas has to do with how well the surfaces in each environment absorb and hold heat.

Education Standards addressed

Next Generation Science Standards

Performance Expectation	Disciplinary Core Ideas	Crosscutting Concepts
MS-ESS3: Earth and Human Activity Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	**ESS3.C Human Impacts on Earth Systems** Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)	**Cause and Effect** Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. **Connections to Engineering, Technology, and Applications of Science**: Influence of Science, Engineering, and Technology on Society and the Natural World The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

National Geographic Standards

8th Grade	Student Knowledge	Performance Expectations
Geography Standard 1: How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information	**Using Geospatial Data to Construct Geographic Representations** 3. Geospatial technologies – internet-based mapping applications, GIS, GPS, geo-visualization, and remote sensing- can be used to construct geographic representations using geospatial data **Using Geographic Representations**	Analyze environmental change by annotating a series of remotely sensed images of the same location taken at different dates.

	4. The use of geographic representation to ask and answer geographic questions	Analyze printed and digital maps to observe spatial distributions and patterns to generate and answer geographic questions (e.g., use digital census data to determine demographic patterns in a state, or analyze census data and transportation routes to identify and locate services, such as a day care center or stores needed in a region).
Geography Standard 14 How human actions modify the physical environment	**The Use of Technology** 2. The use of technology has changed the scale at which people can modify the physical environment	Describe and explain how green construction techniques may increase sustainability and reduce the scale of human-induced effects on the physical environment (e.g., reduced energy use, the use of new sustainable building materials).
	Consequences for People and Environments 3. The physical environment can both accommodate and be endangered by human activities	Analyze the positive and negative effects of human actions on the lithosphere (e.g., land degradation and erosion, soil salinization and acidification). Analyze the proportion of built area to vegetation land cover around a community and identify possible consequences in changes to that proportion (e.g., habitat changes, heat island effect, water and wetland patterns). Analyze the ways humans can have positive effects on the physical environment (e.g., open green space protection, wetland restoration, sustainable forestry).

Warm-Up (5 minutes)

Display image (found on page 13) on a screen for the entire class and pose the question of, "*What's going on in this picture?*" Have students turn to their neighbor and give them a few minutes to discuss their ideas. Then, have the students discuss their ideas as a class.

Image Description

Notable features are described in the Appendix pages 14-17 for the Instructor's reference. Please note that north is straight up in this image, and the surface temperature scale shown below.

Scale

hot

cool

The image was acquired on July 23, 2023 at 15:39UTC (11:39 local time) by Landsat 9 (satellite) Thermal Infrared Sensor-2 (TIRS-2). This sensor is capable of measuring the surface (skin) temperature of the landscape. The other sensor on Landsat 9 is the Operational Land Imager (OLI) that measures visible to mid-infrared energy.

Reading Activity (5 minutes)

Once the warm-up discussion has ended, direct the students to the read the following two articles.

National Geographic Urbanization Encyclopedic Entry

NASA Earth Observatory Dublin Urban Expansion

Hands on Activity: Become an urban planner and delineate different land uses

Optional reference to provide context: World Resources Institute How Land Use Paints a Clearer Picture of Urban Life.

Read this to students: Urban planners need to know which areas of a city are used for which purpose. Therefore, they produce a map of "land use", that identifies parts of a city and the major activities (land use) that happen there. Remote sensing imagery is very useful for this purpose, since you certainly don't want to spend many weeks or months walking or driving around a city to map its land use. But to use remote sensing imagery effectively, you have to be able to interpret it accurately.

There are two options for the activity below. Option A requires a computer, while Option B has students working from a paper copy of the image

Option A: Google Earth Activity (15 minutes)

: In this activity, students will become urban planners and create a map of the land use around either their school or home. Detailed step by step instructions are found in the Appendix pages 18-22.

Supplies Needed: Computer with a mouse and ability to save to local drive

Students can work individually or 2-3 students in a group

Option B: Mapping Landuse Activity (15 minutes)

: In this activity, students will become urban planners and create a map of the land use in an area of Stanton Island, New York City. Print the image and instructions found on page 23, and have the students follow the instructions.

Supplies Needed: Printout of the image and instructions page, color pencils, ruler

ANSWERS:

Bridge length is approximately 150 meters

Stanton Mall complex area may range from 435,000 m2 to 808,000 m2 (or 0.4 to 0.8km2) depending on how students interpret the mall complex

Hands on Activity: Learn about Urban Heat Island

Have the students read NASA Earth Observatory Kids Urban Heat Island pdf (pages 1-6). Then, proceed with the activity.

ESRI Landsat Explorer Exploration (20 minutes)

Supplies needed: Computer, and print out of worksheet found on page 24 and instructions pages 25-26

Start with going to page 5 of the Urban Heat Island pdf to show the students the New York City land surface temperature (left) and vegetation images (right). Tell the students they are going to display similar images for the most recent summer season. Have the students follow the step by step instructions.

To extend the lesson, you may consider the optional analyses below.

Optional Analysis to extent the ESRI Landsat Explorer lesson (5 minutes each)

1) *Create a SPECTRAL profile*
   Instructions in the Appendix page 27

2) *Display CHANGE detection*
Instructions in the Appendix page 27

3) *Compare Urban Heat Islands of U.S. Cities*
Have the students read NASA Earth Observatory Urban Heat Island pdf page 7. Ask the students to pick another large U.S. city in eastern or central U.S. such as Minneapolis and Atlanta. View the Natural Color and/or Urban renderer first and then Surface Temp renderer. Have them share back how warm the city is in comparison to surrounding farm fields, forests, rivers and lakes. You may even want to identify how much warmer larger cities are then smaller ones.

View Video on Urban Planning and Sustainability (5 minutes)

View one of the videos below as a class and then pose a few questions to the students as think-pair-share group or as a whole class.

How Green Roofs Can Help Cities (3 minutes 49 seconds duration). This video from NPR discusses how green roofs can benefit city buildings by reducing temperatures, increasing biodiversity, saving stormwater runoff, and decreasing energy use. Students will learn how green roofs can help solve some significant environmental problems in cities, and how empty urban roof space can be viewed as an opportunity to make cities greener.

Ask students to share if they have ever seen or walked on a green roof.

Urban Trees: Nature works everywhere (4 minutes 44 seconds duration). This video from The Nature Conservancy, provided by PBS LearningMedia, and discusses how trees can help to reduce pollution, energy use, summer temperatures, and noise in cities. Students will learn how urban residents can help protect and care for the trees in their area.

Ask students how many trees are around their school or home? Ask them to identify places that trees may be planted around the school or home to help keep the environment cleaner and cooler.

Career Exploration (5 minutes)

Have the students navigate to the My DOI Career website and explore careers within the United States Department of Interior. Suggest searching for job titles students may be familiar working in urban areas (Click **Explorer Careers** and then enter the keyword in **Keyword Search** such as geospatial, geographical, urban, planner). Or, suggest the following careers to investigate: geographers, cartographers and cartographic technicians, physical science technician, botanist,

outdoor recreation planning, public affairs specialist, and safety and occupational health managers careers. Once a career is selected, the page gives details about job qualifications and if the students scroll towards the bottom of the page, they can explore more specific jobs within that category.

If there is additional time or if you want to make this a longer activity in the future, begin by navigating to My DOI Career website. Scroll to the bottom of the page where students can click on "**Find Your Path**" and then click "**Get Started**" to search careers based on their personal interests.

Wrap-up (5 minutes)

Have the students play one of the three **Wordwall** online games to test their comprehension of the main topics of the lesson.

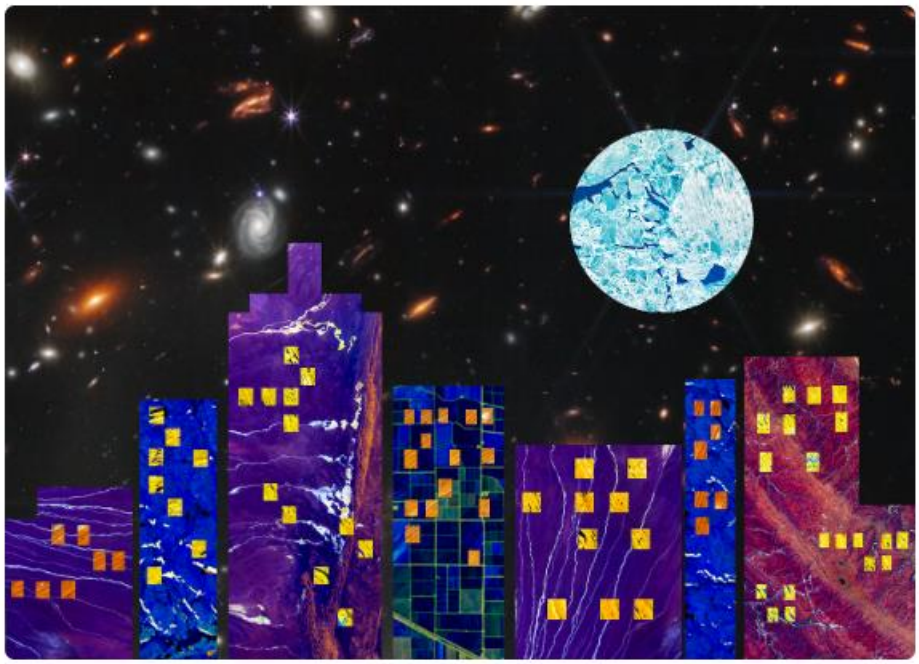
a) Urban Land Use and Planning **Word Search**
b) Urban Land Surfaces **Labelled Diagram**
c) Urban Land use, Impacts, and Sustainability **Complete the Sentence**

Printable quizzes are also provided on page 28-30.

Extra Hands on Activities to enhance learning and bring in creativity and problem-solving involving building sustainable roof.

Creative Activity: Make an urban landscape collage

Students create an urban landscape using satellite imagery. The picture below is an example of nightscape collage. Instructions and materials at found at NASA Landsat collage.



Data Detective Activity: Finding islands

Students compare an Earth at Night image with a surface temperature map. Maps and instructions found at NASA Earth Observatory Kids – Urban Heat Island pdf page. Printout of pdf page found in the Appendix on page 31.

Marker Corner Activity: Green roof birdhouse

Students create a birdhouse with a green roof. Follow instructions at NASA Earth Observatory Kids - Urban Heat Island. Printout of pdf page found in the Appendix on page 32.

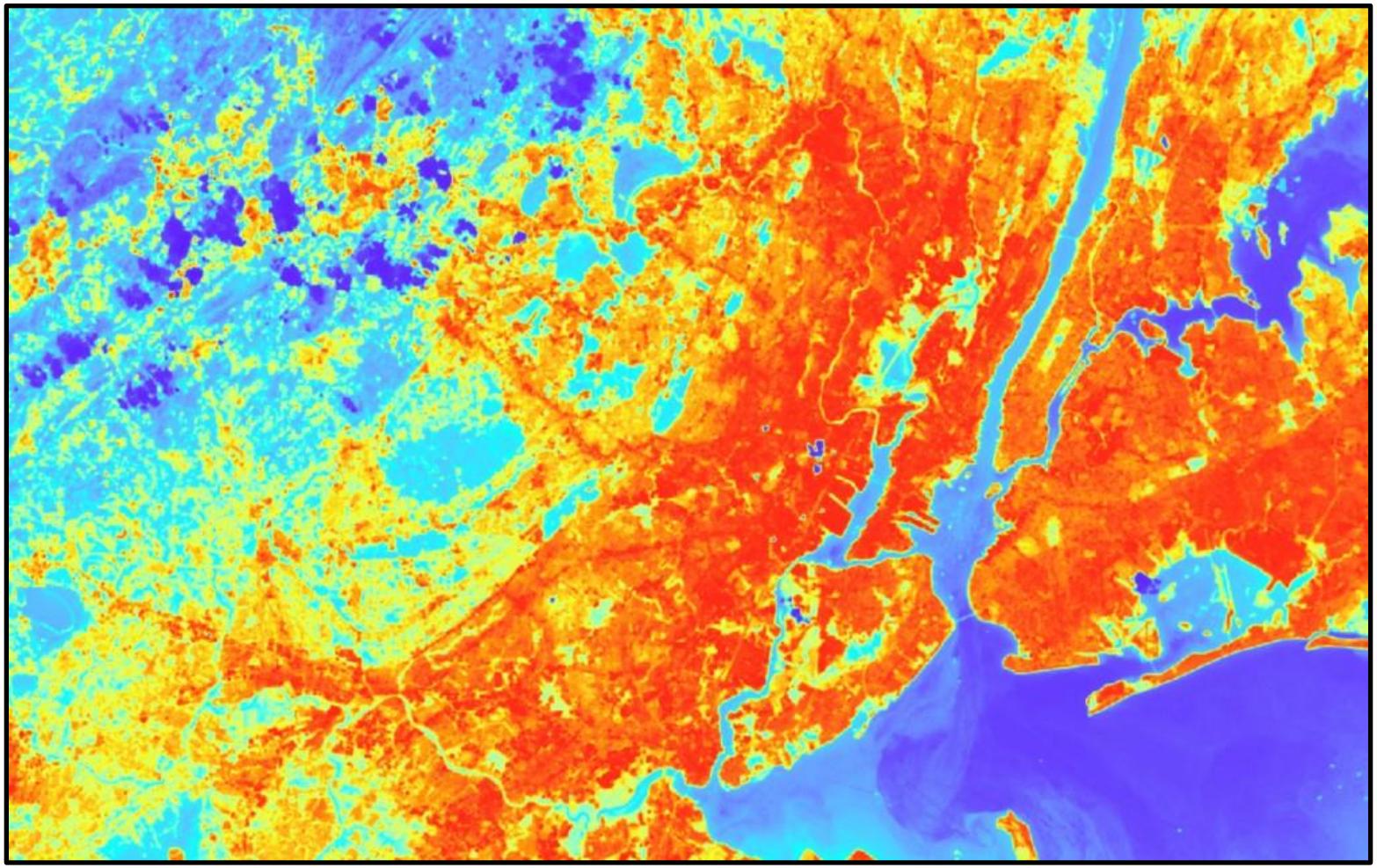
APPENDIX

Warm-Up Image

What's going on in this picture?

What do you notice?

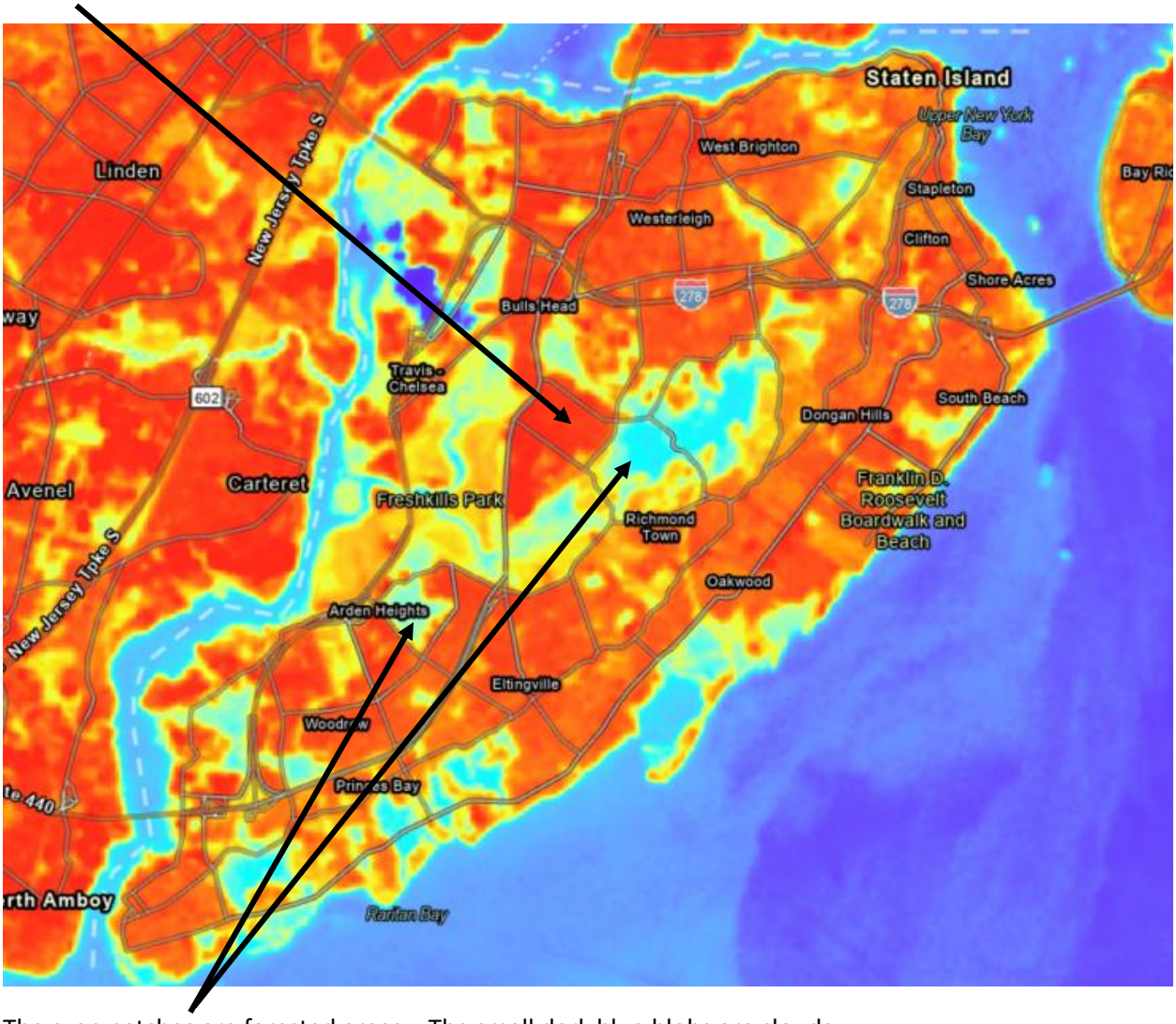
What do you wonder?



Description of notable image features in the Warm-Up Activity

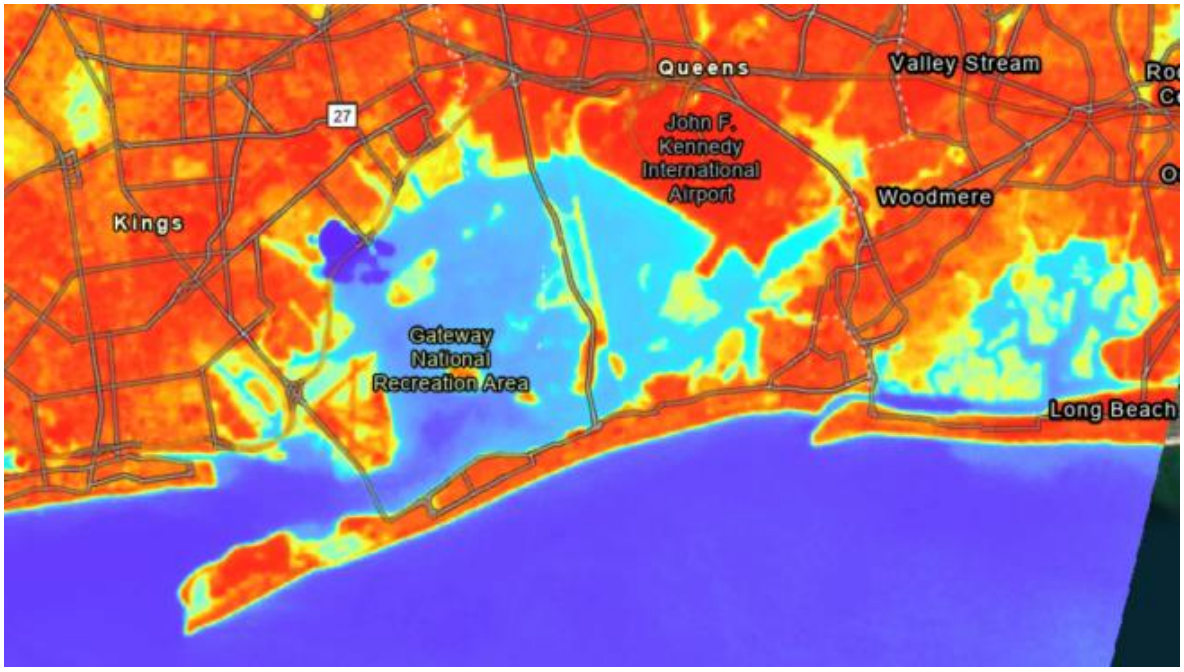
The images found below are zoomed in portions of this large image to illustrate the interesting features displayed.

Image below shows surface temperature, ranging from purple and blue (cool) to orange and red (hot). The blue areas in the lower right corner of the image are the Atlantic Ocean. You can easily find the rivers draining into the Atlantic Ocean, such as the Hackensack River and Hudson River, by following the channels northward from the Atlantic Ocean displayed in varying blue tones. The small red patch (hot) located on Stanton Island, designated by arrow, is the Stanton Island Mall and high-density buildings encompassing man-made pavement and rooftop surfaces.

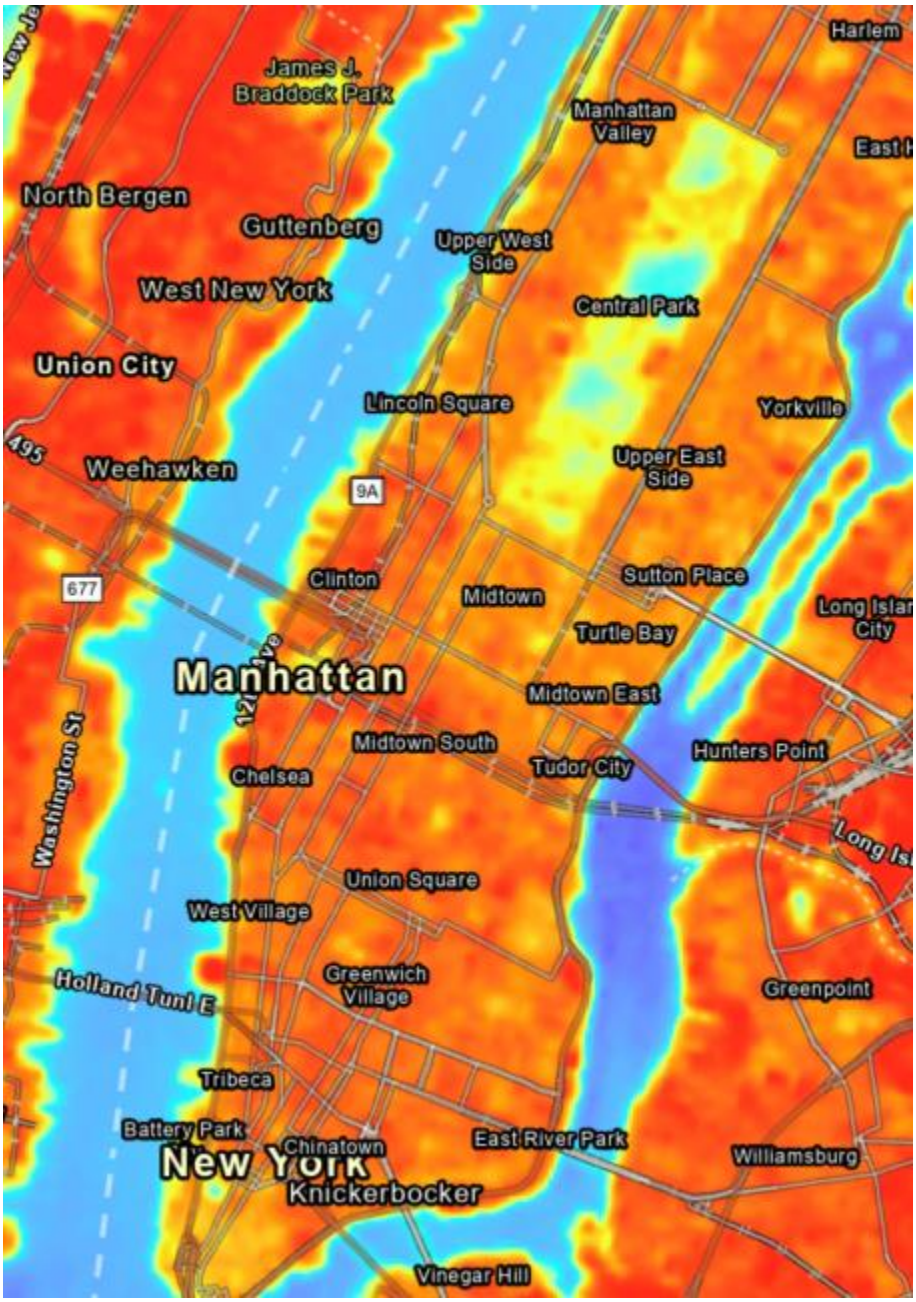


The cyan patches are forested areas. The small dark blue blobs are clouds.

On the zoomed in image below, notice how much colder these area from even the ocean. Also, see how red the Long Island beach is with all the dense urbanization.



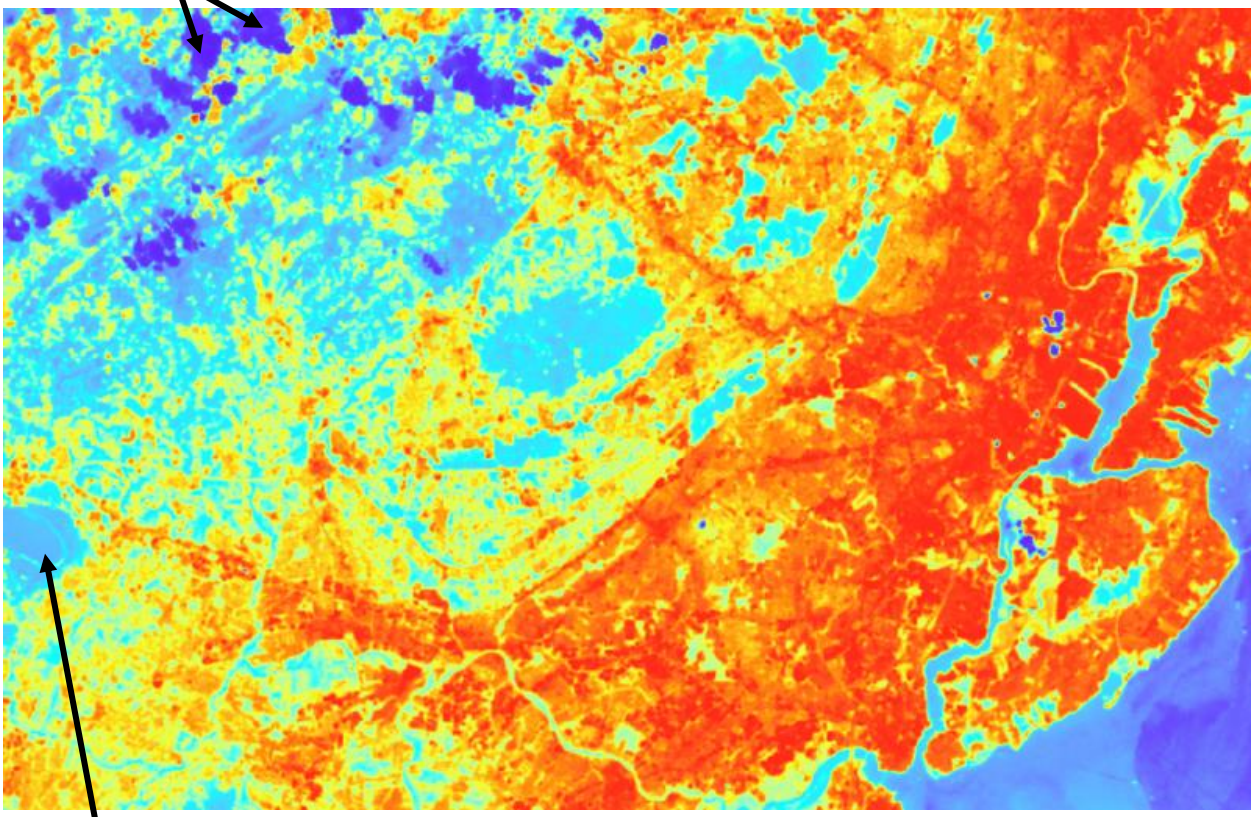
On the image below, locate Manhattan and find Central Park in yellow indicating cooler land surface and Central Park ponds in even cooler cyan tones.



It's also interesting to see that the New Jersey area adjacent to the Hudson River is warmer (higher density) than the Manhattan area.

On the image below, notice the gradation of cooler colors as you look westward from the heart of New York City. As the vegetation increases and urban areas become less dense (less concrete, asphalt and roof tops), the surface temperatures cool. Highly dense urban areas are much warmer where there is little or no vegetation.

See if you can locate the clouds (much colder in dark blue color) in the upper left portion of the image. These features are puffy cumulus clouds that often develop of summer days.



Lastly, find the Round Valley Recreation shown in cyan color that is on the left center edge of the image. The large lake appears cooler than the surrounding forest, but notice the thin line of warmer (yellow) temperatures associated with the thin grassy and in some places bare soil surrounding the lake.

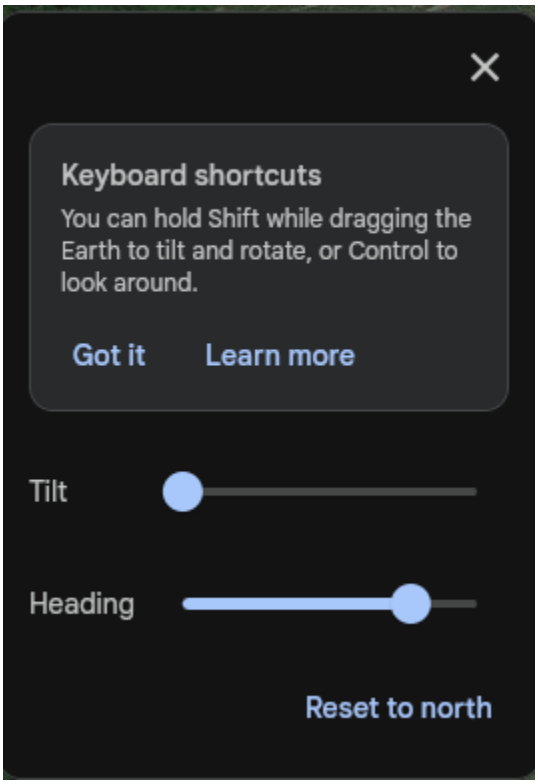
Option A: Google Earth Activity

Steps:

1) Open a web browser and go to [Google Earth]

2) In the **Search Google Earth** dialog box (upper left corner), enter your school or home address. Click on the correct address that appears under Places.

3) Click **Show heading and tilt controls** icon (lower right corner) and click **Reset to north**. Close window by clicking **X**.



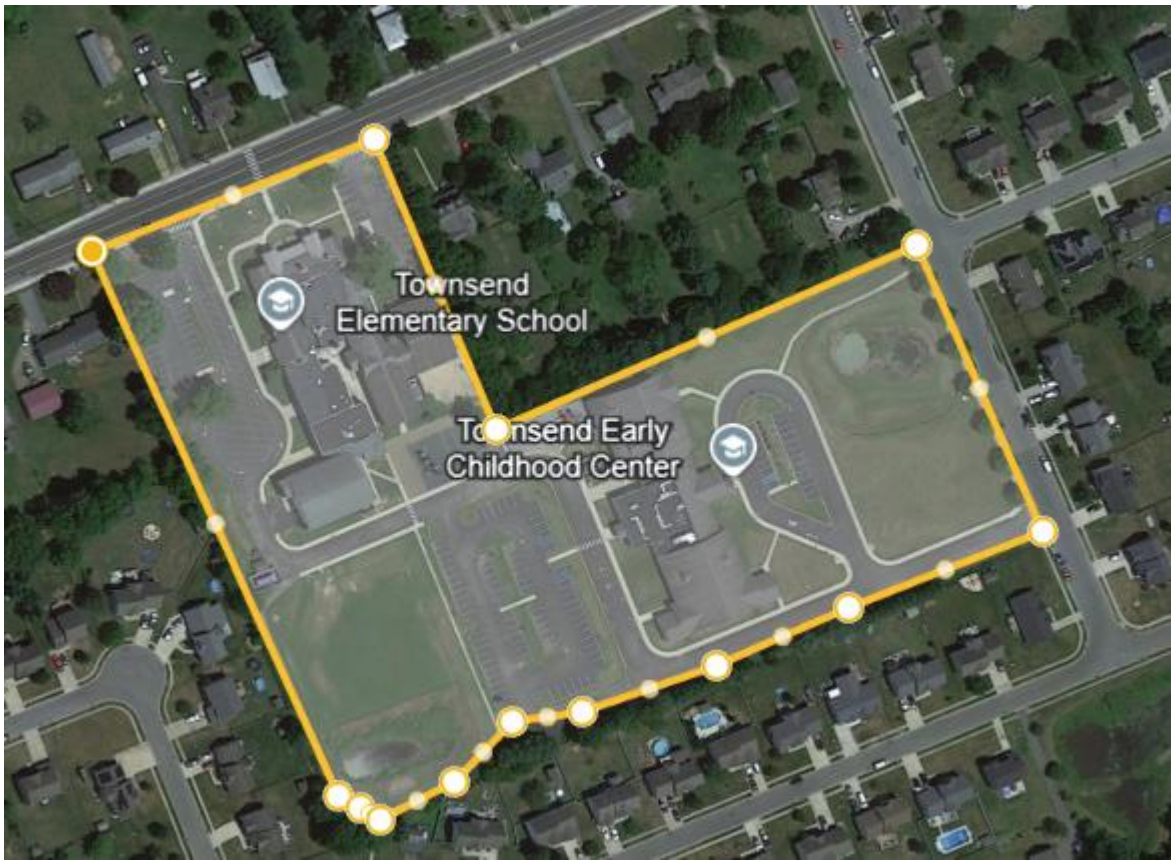
4) Next, click 2D icon to display the image from the view of flying directly overhead

5) Carefully view the natural color image. The image is what you would see flying overhead with our natural eyes. Zoom in so you can see individual features like buildings, parks, agricultural fields so the scale bar number is 100m or smaller (or smallest available for the area of interest)using your mouse or the navigation -+ icons in the lower right corner.

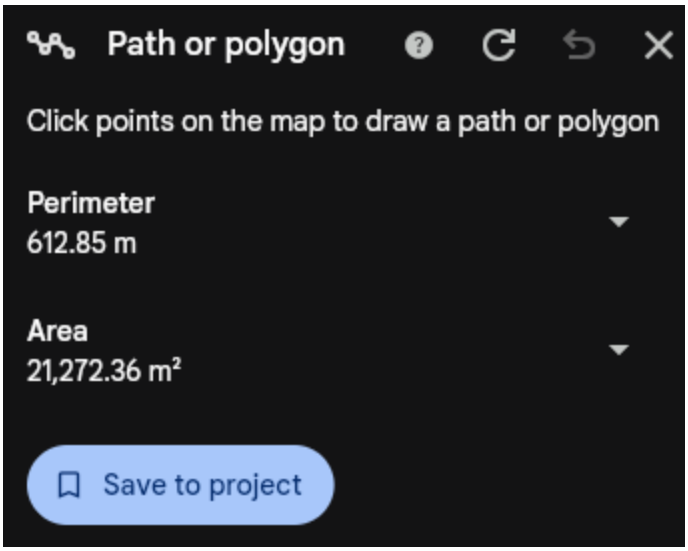
6) Now, create three or more polygons (areas) that represent different land use types. For example, if you are looking at your school, digitize the entire school grounds as one polygon, an adjacent residential area as a second polygon, and a park, forest as a third polygon. To start, identify a landuse type feature of interest.

   a. Click **Add** menu, and then click **Path or Polygon**

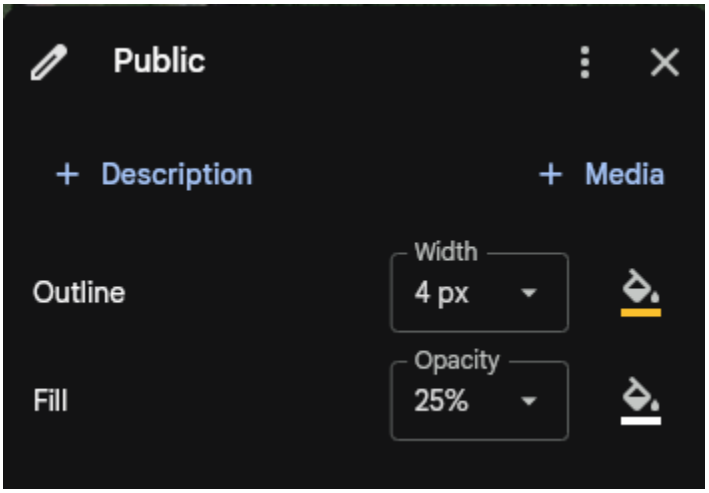
   b. Now, click on points on the land surface to capture the boundary of the feature of interest. A straight line is created between each point you select. So, to create a curved line, you place more closely space points.



   c. Click **Save to project,** and then click **Local kml files** (or Drive project if you have access)

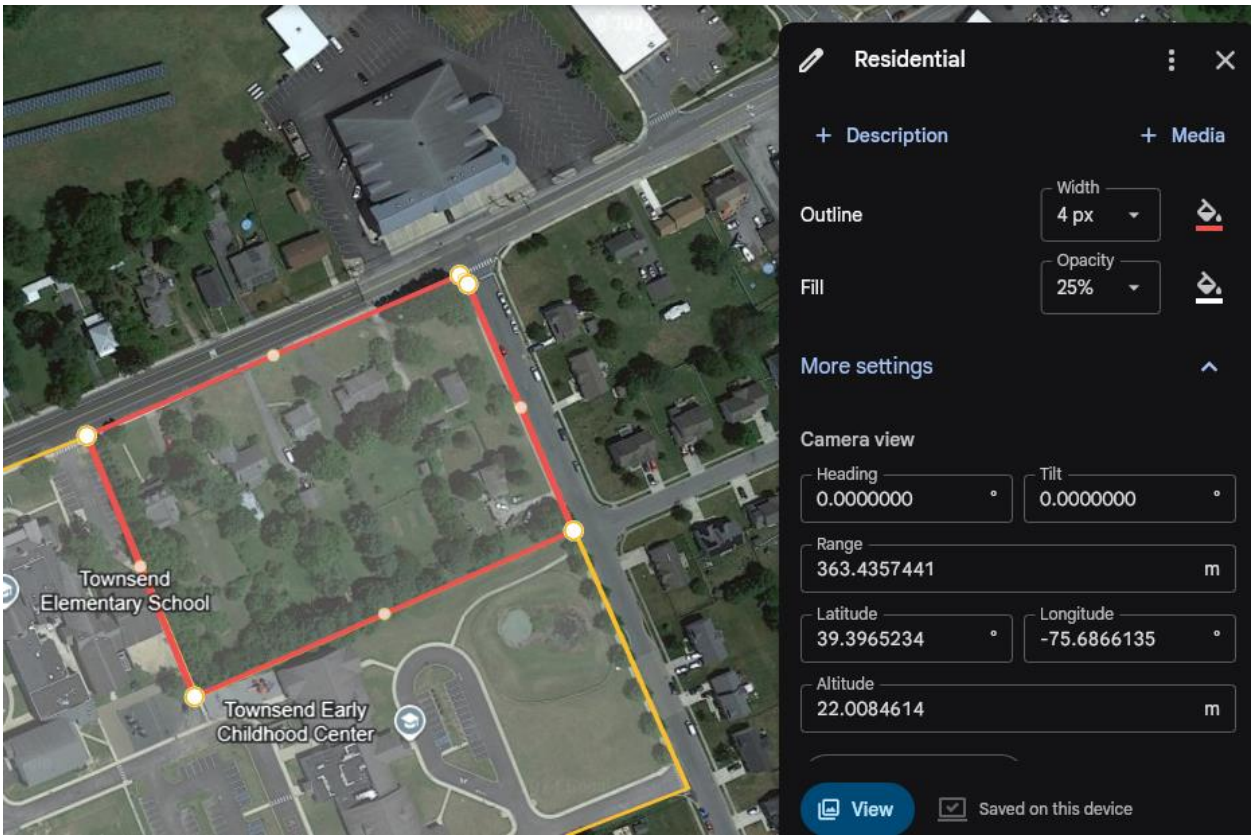


d. Enter a name for the polygon landuse type. For example, for your school grounds title as “Institutional” or “Public”, or for your home title as “Residential”. Then, select an outline color for the polygon.



e. Notice that the layer you are creating is shown on the left black panel. Click **Local KML files** dropdown arrow. Each polygon feature you select is listed. You can click on a feature to see its details and to edit the feature. You can also provide a name for the layer like “Land Use of my School”.

f. Next, find a second land use type feature of interest. Again, click **Add,** and then click **Path or Polygon**. Digitize the land use boundary. Enter landuse type name and a different color.



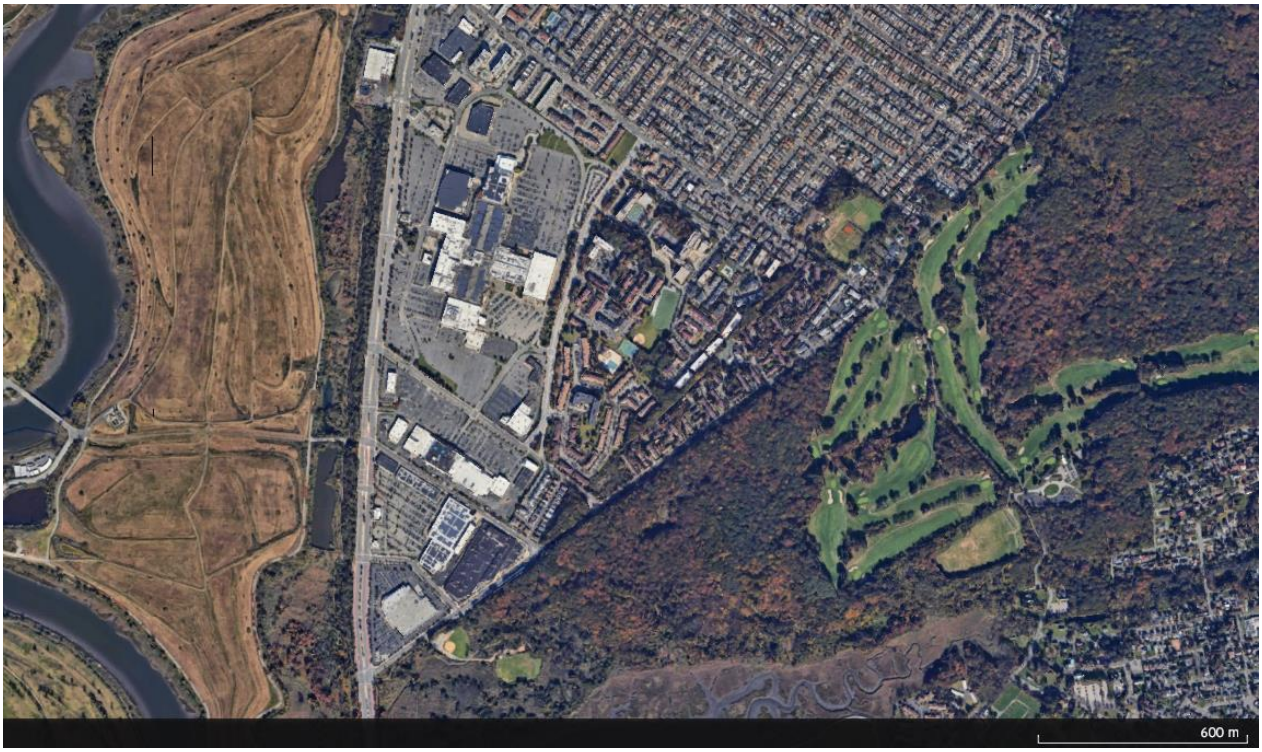
g. Digitize a third polygon like water or forest. Continue additional features as time allows.

h. Record on paper the area of each feature to the nearest whole number and compute the total area you digitized in square meters by summing the polygon areas using a calculator. Convert the area in square meters to square kilometers by dividing by 1,000,000. Turn in your answers

(Total area of polygons in square meters) / 1,000,000 = Area in square kilometers

Option B: Mapping Landuse Activity

NAME: _____



1) Carefully view the natural color image captured from Google Earth. This image is what you would see flying overhead with your natural eyes. See all the individual land use features like Stanton Mall (big buildings with lots of surrounding parking lots), high density residential areas, a gold course, forests, and new development being constructed (bare soil with roads).

2) Using colored pencils, draw three or more polygon lines (lines to denote areas) that represent different land use types – high density residential, commercial (mall), water, forest, and recreation (golf course label as park). Make a thick line to denote the boundary, and lightly shade in the area with the same boundary color. Use a different color pencil for each polygon.

3) Create a legend under the image to represent each land use type. Insert a title at the top of the map to define the purpose and content of the map. This map is a representation of what a geographic information system (GIS) is able to do.

4) Your last challenge as an urban planner is to use the scale bar to compute the approximate length of the bridge in the left center edge of the image. Record the length in meters. Next, calculate the areal extent (area) of the Stanton Mall complex. Record the area in square kilometers.

Learn about the Urban Heat Island Activity

Name: _____

Landsat Explorer Worksheet– Exploring New York City and surrounding areas

RENDERER	BANDS	Usefulness	Feature Color or Temperature
Natural Color			Manhattan: _____ Central Park vegetation: _____ Central Park pond: _____ Forests: _____ Water: _____
Urban			Manhattan: _____ Central Park vegetation: _____ Central Park pond: _____ Forests: _____ Water: _____
Agriculture			Manhattan: _____ Central Park vegetation: _____ Central Park pond: _____ Forests: _____ Water: _____
NDVI Colorized			Manhattan: _____ Central Park vegetation: _____ Central Park pond: _____ Forests: _____ Water: _____
Surface Temp			Manhattan: _____ Central Park vegetation: _____ Central Park pond: _____ Forests: _____ Water: _____

OBSERVATIONS of change over time: Record a brief description of how the surface temperature for Manhattan has changed for the month you selected over time.

Record your observations for Central Park pond or Hudson River.

Compare and contrast these changes over time

ESRI Landsat Explorer Exploration

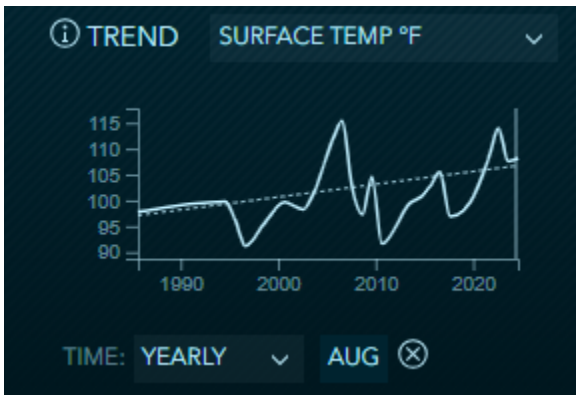
Steps

1) Have the students navigate to ESRI Landsat Explorer web application

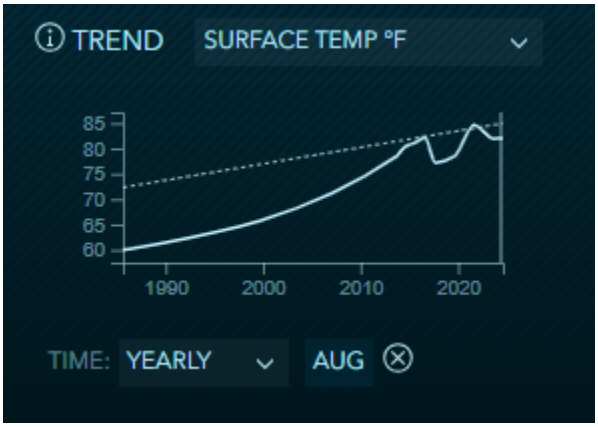
2) In the **Find address or place** search dialog box, type "New York City" and press ENTER

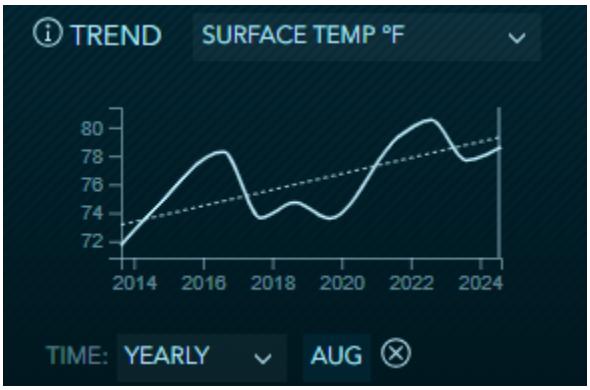
3) Next, fill out the bottom black portion of the window to select a scene and renderer (3-band image display)
    a. With the EXPLORE tab selected, click **FIND A SCENE** tab
    b. For the SCENE SELECTION, select the following:
        i. Cloud to **30%**
        ii. Mission - first click **ALL** then select Landsat **8** and **9**
        iii. Year – most recent year (or past year)
    c. For the months – select a box that is filled in during July or August which means a scene is available given the criteria was have already selected.
    d. Zoom in to Manhattan, so it's in the middle of the image display window.
    e. Now, let's switch between RENDERERs. These are 3-band image composites that emphasize particular features using different band combinations. On the Worksheet, fill in the bands used for each 3-band composite, what the renderer emphasizes and the color of highly urbanized area of Manhattan, Central Park, Central Park pond, forested areas, and water.
        i. Let's start with **Natural Color**. This band combination is actually what our eyes see using the blue, green and red bands of Landsat sensor displayed in blue, green, red display of your computer. Record the color displayed for the features listed on the worksheet.
        ii. Next, switch to **Urban**. Hover over the Urban renderer to identify the bands used and what the composite emphases.
        iii. Then switch to **Agriculture** and **NDVI Colorized**
        iv. For the **Surface Temp** renderer, record the color and the approximate temperature. Hoovering over the Surface Temp renderer brings up the temperature legend (scale)

    f. Next, let's look at how temperature has changed over time.
        i. First, check that you have the Surface Temp renderer displayed. Click on the **ANALYZE** tab (far left). Click the **TEMPORAL profile** tab. Then, click highly urbanized Manhattan (darkest red patch you can find). Examine the graph that is displayed (year on x-axis and surface temperature on y-axis for the month selected). Record a description of how the surface temperature has changed for this month over time.



ii. Click next on Central Park pond or Hudson River. Again, record description and compare and contrast with your observation of Manhattan.





g. Lastly, go to your home or school and examine the Urban and Surface Temp renderers. Start by clicking the **EXPLORE** tab and enter your address or school name along with your city and state in the **Find address or place** dialog box (upper right corner). Select a scene. Click the **Natural Color** or **Urban** renderer. Then, click **Surface Temp** renderer. Look at how much has changed over time (click **Analyze** and **TEMPORAL** profile) and click on a feature of interest. Record your observations

Optional Analysis to extent the ESRI Landsat Explorer lesson

SPECTRAL profile: Try out the SPECTRAL profile tool which allows you to see how the reflectance changes in each band for a specific land surface type. Our eyes can only see the blue, green and red bands. Click on the **ANALZE** tab and then **SPECTRAL profile** tab, and then click on a land surface area of interest. Check out the graph that displays the different Landsat bands on the x-axis and the surface reflectance captured by the sensor on the y-axis. As you click on different land cover types, notice how the curves change. It's really cool to look at forest versus water, or urban versus forest.

CHANGE detection: Another really cool aspect of this application, is that you can look at change over time.

a) Click on the **ANALYZE** tab, and then click **CHANGE detection**

b) Click **SCENE A,** and select a current image from Landsat 8 or 9 mission

c) Next, click **SCENE B** and select an image during the same month 10 to 20 years ago. First, select **Mission: ALL** and a year of interest, and then select a date available

d) Click **VIEW CHANGE Scene A – Scene B** tab. The CHANGE panel allows you to select how the change is computed (does not offer surface temperature change). Make sure the VEGETATION INDEX option is specified that displays how greenness has increased or decreased. Notice the dark blue (greenness increased) and brown (decreased).

Urban Land Use, Planning, and Sustainability

Date: _____ Name: _____

1. Landuse
2. Image
3. Urban Heat Island
4. Classification
5. Trees
6. Asphalt
7. Surface temperature
8. Urban
9. Impervious
10. Green roofs
11. Remote sensing
12. Runoff
13. Transpiration

Q	Q	Q	A	S	K	Y	I	O	X	L	F	N	J	K	R	E	S	C
U	P	H	E	O	W	I	Z	J	D	N	Y	T	K	B	H	F	D	F
B	R	E	N	C	N	A	P	X	S	S	H	X	N	P	F	O	B	R
N	R	B	I	H	L	A	L	H	R	X	V	H	S	M	I	Q	Y	E
T	I	F	A	M	L	A	A	S	P	H	A	L	T	Q	O	D	Q	M
T	R	U	D	N	P	E	S	X	Q	I	K	L	P	X	Y	K	K	O
C	R	O	R	Y	H	E	Y	S	O	K	L	I	X	C	U	K	J	T
G	Y	A	P	F	G	E	R	S	I	T	Z	Q	N	Q	E	F	M	E
Y	N	M	N	V	B	G	A	V	P	F	J	N	E	W	G	G	I	S
M	V	G	Z	S	N	Z	V	T	I	E	I	M	K	H	X	X	G	E
B	C	Q	Z	X	P	J	U	R	I	O	G	C	R	F	L	O	R	N
B	I	M	A	G	E	I	B	P	B	S	U	L	A	U	G	E	Y	S
C	Z	K	I	D	P	A	R	I	J	F	L	S	A	T	N	K	I	I
H	P	P	U	R	B	A	N	A	P	Y	P	A	E	N	I	O	H	N
J	Y	H	C	S	V	D	T	W	T	C	S	N	N	N	D	O	F	G
Y	S	U	N	L	L	W	F	W	A	I	W	I	M	D	Y	U	N	F
U	G	R	E	E	N	R	O	O	F	S	O	J	Q	P	N	H	S	V
G	V	D	F	J	I	Y	E	P	S	G	L	N	B	S	Q	Z	R	E
S	U	R	F	A	C	E	T	E	M	P	E	R	A	T	U	R	E	L

Urban Land Surfaces

Date: _____ Name: _____

Enhance surface temperature

Impervious surface at ground level

Filter rainwater

Lower surface temperature

Absorb rainwater

Wordwall

wordwall.net/r/77377807

Urban land use, its impact, and sustainability

Date: _____ Name: _____

1.

temperature cool trees impervious surfaces rural transpiration hot Landuse urban

_____ reveals the patterns of a city, from road networks to housing availability to the distribution of commercial and industrial space — along with the jobs they represent — and much more. To house and transport all the people living in a city takes a lot of buildings, streets, and sidewalks called _____. Pavement makes cities _____, and plants make them _____. Trees, shrubs, and grasses provide their own natural air conditioning through _____. On a hot summer day, the _____ in the center of _____ New York City can be 4°C higher than the surrounding _____ areas with forests and farms. Urban _____ provide so many benefits in our cities; they interrupt and slow rainfall, reduce runoff, filter pollutants, and provide lots of other advantages to us.

Data Detective

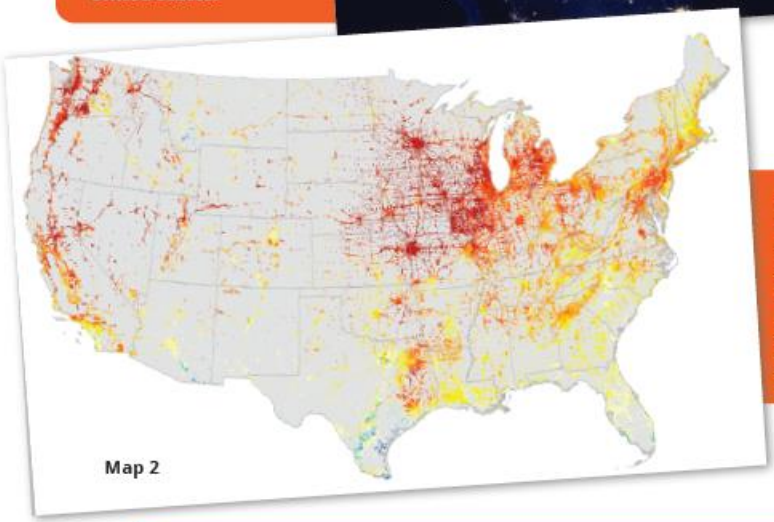
Finding Islands on the Land

When viewing the Earth from space, there is no question that humans have changed our planet. Both maps appear to have *islands* of light or heat. Why? Be a data detective and solve the mystery of the *islands* on the land.

– *D. Janney and T. Owen*

Map 1

Map #1 shows lights at night across the United States.



Map 2

Map #2. This map shows us where heat is being absorbed by impervious surfaces across the United States.

Red shows where land surfaces are hotter than their surrounding areas.

1. **What do the brightest areas on the first map and the red areas on the second map have in common?**
2. **What are the dotted lines that appear to connect the brightly lit locations to each other on the first map? What about the lines on the second map?**
3. **Why are these dotted lines appearing on both maps?**

Answers on page 15 of EOKids Urban Heat Islands Issue
earthobservatory.nasa.gov/blogs/eokids/eo-kids-urban-heat-islands/

Maker Corner

Green Roof Birdhouse

Have you ever seen a roof with trees and plants growing out of it – on purpose? Many materials like tile and shingles absorb heat during the day and release it at night, making cities warmer. One solution to this problem is to build green roofs.

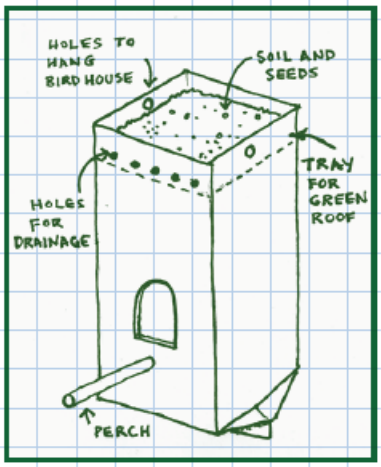
Like giant planter boxes, green roofs replace solid roof surfaces with soil and plants. This helps moderate a building's temperature and allows water to soak in rather than run off.

Green roofs adjust to create an ideal surface for each season. The plants shed their leaves in the winter, revealing dark soil that absorbs energy and keeps the building warmer. In the summer, the plants provide shade and give off water vapor, keeping the roof surface and the inside of the building cooler.

Not only do green roofs reduce energy use for heating and cooling in individual buildings, they can also help cool the city. Green roofs are one way to reduce the effects of urban heat islands. — *K. Weaver*

Green Roof Neighborhood

This special apartment building in a suburb of Copenhagen, Denmark is called "8 House" due to it's unique shape – it looks like the number 8 from above. Another thing that is special about this building is what is growing on top. The "8 House" has grassy/mossy vegetation growing on its sloped roofs.



Materials:

• half-gallon carton • scissors • stapler • string • soil • grass seed • stick for a perch • paint or other decorations

Instructions:

1. Staple the top of the carton closed (if needed).
2. Cut off the bottom of the carton and flip it over to make a flat tray. Staple to the bottom of the carton as shown.
3. Use the scissors or a nail to (carefully) make a few small drainage holes around the side of the tray, and two larger holes to attach the string for hanging.
4. Cut a hole in one side of the carton for the birds to enter.
5. Decorate the outside and add the perch.
6. Add the soil to the tray, sprinkling seeds on top.
7. Water your green roof (not too much) and watch as it grows!

Be Inspired:

Try making a green roof for a larger birdhouse, a doghouse, or a shed (with adult permission, of course). What might you have to do differently for a larger roof? For example, how much weight can the roof structure support? What could you use for drainage under the plants?